

CLAIMS

1. A switching regulator converting an input voltage into a predetermined constant voltage and outputting
5 the constant voltage from an output terminal, the switching regulator comprising:

a switching transistor controlling output of the input voltage by switching in accordance with a control signal input to a control electrode;

10 a smoothing circuit part configured to smooth an output voltage of the switching transistor and output the smoothed output voltage to the output terminal;

a control circuit part configured to control the switching of the switching transistor in synchronization with
15 an externally input clock signal so that a voltage at the output terminal is the predetermined constant voltage; and

a clock signal detector circuit part configured to detect presence or absence of inputting of the clock signal,

wherein upon detecting stoppage of the inputting of
20 the clock signal, the clock signal detector circuit part causes the control circuit part to stop operating and perform a standby operation for reducing power consumption and thereby to turn off the switching transistor.

25 2. The switching regulator as claimed in claim 1,

wherein upon detecting the inputting of the clock signal, the clock signal detector circuit part causes the control circuit part to start operating and perform a normal operation and thereby to perform the switching of the switching transistor.

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3. The switching regulator as claimed in claim 1, wherein the clock signal detector circuit part comprises:

an edge detector circuit configured to detect at least one of a rising edge and a falling edge of signal level
10 of the clock signal and output a pulse of a predetermined pulse width for the detected at least one of the rising edge and the falling edge every time the at least one of the rising edge and the falling edge is detected;

an integrating circuit configured to charge a
15 capacitor with a preset time constant;

a switching device configured to release an electric charge stored in the capacitor upon the outputting of the pulse from the edge detector circuit; and

a binarizing circuit configured to generate a
20 control signal to perform operation control of the control circuit part by converting a terminal voltage of the capacitor into a binary signal, and output the generated control signal.

4. The switching regulator as claimed in claim 3,
25 wherein the time constant is preset for the integrating

circuit so that a period between stoppage of the release of the electric charge stored in the capacitor by the switching device and completion of the charging of the capacitor up to a predetermined voltage is longer than an interval at which the pulse is output from the edge detector circuit.

5 5. The switching regulator as claimed in claim 1, wherein the control circuit part comprises:

 a reference voltage generator circuit configured to
10 generate and output a predetermined reference voltage;

 an output voltage detector circuit configured to detect the voltage at the output terminal, and generate and output a voltage proportional to the detected voltage;

 an error amplifier circuit configured to compare the
15 reference voltage and the proportional voltage, amplify a voltage difference between the reference voltage and the proportional voltage, and output the amplified voltage difference as an output voltage;

 a triangle wave generator circuit configured to
20 generate and output a predetermined triangle wave signal synchronizing with the clock signal;

 a PWM circuit configured to compare the output voltage of the error amplifier circuit and voltage of the triangle wave signal output from the triangle wave generator
25 circuit, and generate and output a pulse signal for performing

PWM control, the pulse signal having a pulse width according to the output voltage of the error amplifier circuit; and

a drive circuit configured to control the switching of the switching transistor in accordance with the pulse

5 signal from the PWM circuit,

wherein upon the stoppage of the inputting of the clock signal, the clock signal detector circuit part causes each of the error amplifier circuit, the triangle wave

generator circuit, the PWM circuit, and the drive circuit to

10 stop operating and perform the standby operation for reducing power consumption and thereby to turn off the switching transistor.

6. The switching regulator as claimed in claim 5,

15 wherein the clock signal detector circuit part determines that the inputting of the clock signal is stopped if a frequency of the triangle wave signal output from the triangle wave generator circuit does not fall within a predetermined range.

20 7. The switching regulator as claimed in claim 6,

wherein the clock signal detector circuit part detects presence or absence of inputting of the clock signal to the triangle wave generator circuit, and causes the control circuit part to start operating and perform a normal operation

25 and thereby to perform the switching of the switching

transistor upon detecting the inputting of the clock signal to the triangle wave generator circuit after determining that the inputting of the clock signal is stopped.

5 8. The switching regulator as claimed in claim 5, wherein the triangle wave generator circuit comprises:

 a PLL circuit, the PLL circuit including:

 a waveform shaping circuit configured to
convert the triangle wave signal into a rectangular wave
10 signal by shaping the triangle wave signal, and output the
rectangular wave signal;

 a phase comparator configured to compare
phases of the clock signal and the output signal of the
waveform shaping circuit, and output a voltage according to a
15 result of the comparison;

 a filter circuit configured to smooth the
output voltage of the phase comparator and output the smoothed
voltage; and

 a triangle wave oscillator configured to
20 generate and output the triangle wave signal of a frequency
according to the output voltage of the filter circuit,

 wherein upon the stoppage of the inputting of the
clock signal, the clock signal detector circuit part causes
each of the waveform shaping circuit, the phase comparator,
25 and the triangle wave oscillator to stop operating.

9. The switching regulator as claimed in claim 1, wherein the smoothing circuit part comprises a transistor for synchronous rectification connected in series to the switching transistor;

5 the control circuit part controls switching of the transistor for synchronous rectification; and

 the switching transistor, the transistor for synchronous rectification, the control circuit part, and the clock signal detector circuit part are integrated into a
10 single IC.

10. The switching regulator as claimed in claim 9, wherein the IC comprises:

 a first power supply terminal to which positive
15 supply voltage is applied, the positive supply voltage forming the input voltage to be converted into the predetermined constant voltage;

 a second power supply terminal to which negative supply voltage is applied;

20 a pulse output terminal from which a pulse signal from the switching transistor is output;

 an output voltage input terminal to which the voltage output from the output terminal is input; and

 a clock signal input terminal to which the clock
25 signal is input.

11. The switching regulator as claimed in claim 1, wherein the switching transistor, the control circuit part, and the clock signal detector circuit part are integrated into a single IC.

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12. The switching regulator as claimed in claim 11, wherein the IC comprises:

a first power supply terminal to which positive supply voltage is applied, the positive supply voltage forming
10 the input voltage to be converted into the predetermined constant voltage;

a second power supply terminal to which negative supply voltage is applied;

a pulse output terminal from which a pulse signal
15 from the switching transistor is output;

an output voltage input terminal to which the voltage output from the output terminal is input; and

a clock signal input terminal to which the clock signal is input.